LORD, NATHANIEL W. Bad condition of Springfield wells.

WATER SUPPLY.

QUALITY OF WATER USED IN SPRINGFIELD FOR DOMESTIC PURPOSES.—STARTLING REVELATIONS OF CHEMICAL ANALYSIS BY PROFESSOR LORD.

At a meeting of the City Council last (Tuesday) evening George H. Frey of the Water-Works Committee read the report of Prof. Lord, of Columbus, who recently made analyses of the water used in this city in households. The report is given below in full. Its revelations are decidedly startling:

SPRINGFIELD, OCTOBER 19, 1880.

To the City Council of the City of Springfield:—

On behalf of the Committee on Water-Works I hereby submit the report of Prof. Nat W. Lord, of Ohio University, Columbus, on the analyses of water taken from the gravel beds east of Lagonda, in what is supposed to be the original bed of Buck Creek, from the points where it is supposed that the largest and best supply of pure water can be obtained for the supply of this city. The report of Prof. Lord includes the analyses also of the waters of a number of wells, located in various sections of the city, which it is hoped may be of value to our citizens generally in leading to the exercise of discriminating judgment in the use of so important an article as water. Bills covering expenses incurred by your committee to date are herein submitted in memoranda.

GEORGE H. FREY,
Secretary of Water-Works Committee.

BAD CONDITION OF SPRINGFIELD WELLS.

REPORT ON THE RESULTS OF ANALYSIS OF WATER TAKEN FROM WELLS IN AND IN THE VICINITY OF SPRINGFIELD, OHIO, BY NAT L. LORD, E. M., ASSISTANT PROFESSOR OF MINING AND METALLURGY OHIO STATE UNIVERSITY, COLUMBUS.

BEFORE giving the results of these examinations it is important to briefly state the methods used and the reasons for the special determinations made. Natural waters fit for domestic use, are never pure in the chemical sense of free from other substances, but are very dilute solutions of such substances as can be leached out from the earth from which the water is drawn or the air through which, as rains, it falls, the principle of which is carbonates, and sulphates of lime and magnesia, with some chlorides as common salts (or chloride of sodium.)

When present in small proportions these salts are not only not injurious, but perhaps positively beneficial, many waters of good quality containing thirty to thirty-five grains in the gallon. Much more than this would, however, render the water undesirable, making it very "hard" or unfit for washing purposes from not forming a lather with soap. When water is evaporated, these matters are left and can be weighed, constituting the "total solid residue" of the analysis—an important determination, which residue should not exceed in a first-class water the limits above stated.

These salts are then normal constituents of potable water, and, unless excessive, not important. But other matters may occur in water, never present in pure supplies, hence strictly impurities and of the greatest influence in determining its fitness for domestic use. Those most important are the contaminations introduced by the admixture of sewage. It is a well ascertained fact that nothing is a more potent cause of disease than the use of water polluted by the decomposing refuse of houses, stables or cities; hence in examining any water supply the first and most important question is, Does it in any way receive such contamination?

The method of ascertaining this is founded upon the fact that decomposing animal and vegetable matters yield ammonia. Were natural waters always free from this, it would be sufficient to simply test the water for its presence, which is easy to do with the utmost delicacy, but while well and spring waters contain but a trace of this substance, rain water contains it frequently, and hence a further test is necessary, which consists in, after removing from the water all the free ammonia present, testing the remainder for matters capable of yielding ammonia by decomposition, or, in other words, for "organic introgenous substances." The further supply of ammonia thus obtained, known and reported in the analysis as "albumminoid ammonia," is of paramount importance as determining and indicating the extent of sewage contamination. An important element of sewage is salt, or chloride of sodium; hence the presence of an excessive amount of chlorine in water is suspicious unless other causes can be shown to account for it. From the above facts it appears that an examination of water with reference to its potable character should comprise first a determination of the free ammonia, the albuminoid ammonia and the chlorine. Then should the amount of these present be found so minute as not to condemn the water, the amount of the "total solids" and their character should be determined. A few obvious conclusions may be stated as of interest in connection with the analysis to follow:

1st. Rain water may be expected to contain some free ammonia, but no albuminoid ammonia or chlorine.

2d. Well water tainted by fresh sewage should contain little free ammonia, but much albuminoid and chlorine.

3d. Well water from ground well steeped with old sewage may be very high in free ammonia and chlorine.

4th. A well from which much water is drawn and which receives a steady supply of fresh sewage, would show little free ammonia, but much albuminoid in proportion to the extent of the contamination.

As to the quality of sewage dangerous in water, the least trace may be so considered, for while water very slightly tainted may seem harmless for a time, it is pretty well established that in case of fevers and similar diseases water acts as a carrier for the disease even where the slighest communication exists.

The following table of the results of analysis of the Springfield waters reports the ammonia and chlorine in "parts of one million," and I have added a fourth column giving the equivalent sewage contamination in percentages. These latter figures are approximate only, and are based upon the fact that average sewage yields about five parts of "albuminoid ammonia in one million." The figures are, however, rather below the truth than above it. The albuminoid ammonia to the extent of .05 parts may be considered as due to the vegetable matters and not injurious. as the purest water may contain this amount; all above this is suspicious, especially if free ammonia be present with chlorine; and above .10 parts in the presence of free ammonia and chlorine would be highly dangerous.

It must be borne in mind that the ground acts as a filter and extracts much of the deleterious matter from the sewage filtering through it, but the fact that any passes through shows the danger of increase at any time.

The following is the table giving the three determinations referred to for the waters examined :

PARTS IN A MILLION.

City Wells.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Per cent. pres't pts 100 sewage.
No. 1	0.05	0.18	150	2.6
" 2	2.66	0.26	91	4.4
" 3	0.26	0.08	112	0.6
" 4		0.16	28	2.2
" 5	0.05	0.20	undet.	3.0
" 6	1.32	0.10	70	1.0
" 7	0.05	0.14	49	1.8
" 8	1.80		63	1.8
" 9	very	impure	undet.	
" 10	trace	0.04	9	
" 11	0.03	0.05	43	trace
Reservoir water	0.05	0.04	14	
Wells above Lagonda.				
No. 1	0.29	0.04	trace	
" 2	0.03	0.03	trace	
Creek above Lagonda	0.03	0.05	3	

These analyses show the following points clearly: All the city wells examined, excepting the two last (Nos. 10 and 11) give evidence of sewage contamination, though in different degrees and in various ways. The first (No. 1), from its contents in albuminoid ammonia, seems to indicate a stream or copious supply of water mixed with fresh sewage, while the analysis of No. 2 would indicate stagnant, foul water, or a soil soaked with filth. Like this latter well are Nos. 6, 8, and 9, while like the first are Nos. 3, 4, and 5. These latter, probably, are in a bed or stratum through which water flows, continually changing the water in the wells and thus greatly diluting the sewage, while the former wells are probably so situated that the water slowly steeps into the well from a soil saturated with drainage and filth.

The high chlorine contents would show a saturation of the ground with old accumulated debris in which the organic matters had decomposed completely, leaving the ground saturated with the inorganic salts.

The only wells showing no appreciable contamination are Nos. 10 and 11. These seem to have struck a stream of pure water probably protected by clay seams from surface water. No. 11 would seem less pure than No. 10; possibly it receives some surface drainage to account for the higher chlorine, which, under the circumstances of the two wells being on the same general stratum, is suspicious, and would indicate that possibly the well is reached by sewage so completely filtered by intervening soil that only the inorganic salts pass through, and in this case the well might at any time become dangerous.

The reservoir water seems pure, and it very likely gets its water from the same deep layer in the hill that wells Nos. 10 and 11 strike.

The investigation shows a foul state of the whole water-bearing layer. A few more favored localities are probably safe at present, but are liable to become at any moment dangerous.

The progress of filth of this kind through a soil is gradual. Earth and sand act as filters, but as they become gradually choked in time they lose their power, except where exposed to the regenerating

influence of atmospheric oxygen, which is not the case in deeper soils and sands, hence the point to which contamination from a given source will extend, reaches farther and farther until a well or water-bearing layer is reached, and the unfortunate users are perhaps first notified of the occurrence by the breaking out of typhoid fever. The results of this examination may be summed up as follows:

The city of Springfield is built partly upon a gravel terrace, interstratified with clay seams, which furnishes along the base a copious supply of water. When wells are sunk deep enough on this terrace to reach this water, pure water is at present obtained. The lower part of the city, however, is built upon rock thinly covered with gravel and largely fissured over, and through which the water from the gravel terrace above and from the surface drainage runs. The larger part of this ground is simply steeped with water.

This water bearing rock and soil is the principal recipient of the drainage of the city, and is the common location of privy vaults and sewers, and this has become saturated to a great extent with more or less decomposed sewage, so that while isolated spots may as yet have escaped, the majority of the wells of that part of the city are poisonous and filthy.

From the fissured and stratified character of the rocks it serves as an excellent channel for conveying drainage from privy vaults to wells, having little or no power as a filter as earth would act. The analysis shows clearly that in several cases such communication exists, and the above reasons demonstrate that even where present indications show no positive pollution, any well is liable to become dangerous which is dug in that part of the city. Passing to the examination of the two wells above Lagonda, examined with reference to their availability as a water supply: They are both organically pure; that is, free from sewage contamination or organic matter. No. 1 shows some surface-water mixture, probably due to the fact that the well was unprotected at the top. The following is the contents of this water in the other materials referred to in the beginning in grains to the gallon (U. S.)

WELL NO. 1 ABOVE LAGONDA.

Total solid residue,	24.4
Carbonate of lime,	15.5
Sulphate of magnesia,	4.0
Balance principally carbonates of magnesia,	4.9
Total,	24.4

The second well is better than the first.

WELL NO. 2 ABOVE LAGONDA.

Total solid residue,	20.1
Carbonate of limes,	11.3
Carbonate of magnesia,	5.5
Sulphate of magnesia,	0.9
Other salts,	2.4
Total,	20.1

The above analyses show the water to be very satisfactory—a little hard perhaps, but not excessively so. The only possible objection might be the magnesia, but as it is there as carbonate and not as sulphate, and is at best but in quite small amount, it would be no serious objection. So that, as far as analysis shows, the water is of first-rate quality.

In case the water stratum opened by these wells should be used as a supply, too great care could not be used to prevent its future pollution. The conditions as to soil, etc., are the same as lower down probably, and the building of houses and stables around the neighborhood of the filter galleries would introduce into this supply the same impurities which corrupt the wells of Springfield; but if this be guarded against, as it easily can be, there is no reason why it should not furnish an excellent supply. Whether the amount would be sufficient, is for a hydraulic engineer to determine, but probably it is very large.

N. W. Lord.